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ESTIMATING AGE CLASSES IN KING VULTURES (*Sarcoramphus papa*) USING PLUMAGE COLORATION

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KEY WORDS: *ageing*; *king vulture*; *plumage coloration*; *plumage maturation.*

Researchers conducting field studies on sexually monomorphic vultures have utilized molt and plumage characteristics to identify individuals (Snyder et al. 1987, Wallace and Temple 1987). Such characteristics are valuable in determining age classes needed to detail survivorship patterns (Todd and Gale 1970). No reliable criteria are known for age class determination in king vultures (*Sarcoramphus papa*). Wallace and Temple (1987) distinguished six age classes in this species, but they failed to describe which plumage characters they considered. Additionally, Heck (1968) provided scant details of plumage color patterns with no discussion of 5 and 6 yr age classes. In order to determine reliable criteria for age determination in the wild, I examined known-age king vultures in captivity, and documented gross plumage coloration. For a detailed description of the definitive plumage coloration in king vultures, consult Friedmann (1950). A description of natal downs is detailed by Ramo and Busto (1988) and Schlee (1994).

METHODS

Twenty-seven photographs of 16 known-age birds (four males, four females) and eight of unknown sex were taken as follows: three photographs of 1-yr olds, nine of 2-yr olds, five of 3-yr olds, three of 4-yr olds, four of 5-yr olds, two of 6-yr olds, and one of a 7-yr old. Individual birds were photographed from one to five times. Five birds were permanently housed outdoors in San Antonio, Texas. The remaining 11 were maintained at the Detroit Zoological Garden in Detroit, Michigan. The birds in Detroit were exhibited outdoors during the summer months and housed indoors under artificial lighting during the winter months (T. Schneider pers. comm.). Only feathers that change from black to white with maturity were considered: the interscapular and dorsal regions of the spinal tract, ventral tract, and under-tail coverts of the caudal tract. Also considered were the white alar-tract feathers including the seven upper middle coverts, carpal coverts, and all underwing coverts. The final region changing from black to white includes the feathers of the femoral and crural tracts (Fisher 1943).

RESULTS AND DISCUSSION

Five age categories were tentatively distinguished by plumage coloration in captive birds (Table 1) that were consistent with descriptions by Nuttall (1832), Dickey and van Rossem (1938), and Heck (1968). The categories conflict with statements by Brown and Amadon (1968) who indicate that second-year birds have all white underparts and third-year birds are in definitive plumage except for some black in the interscapular region. My findings also are inconsistent with Ruschi (1979) who stated that adult plumage is attained in the second year of life.

Throughout the first year, all contour feathers including retrices and remiges are sooty black (Fig. 1). White down feathers on the femoral and crural tracts can also be considered characteristic of this stage. During the bird's second year flecks of white begin to appear on the femoral,

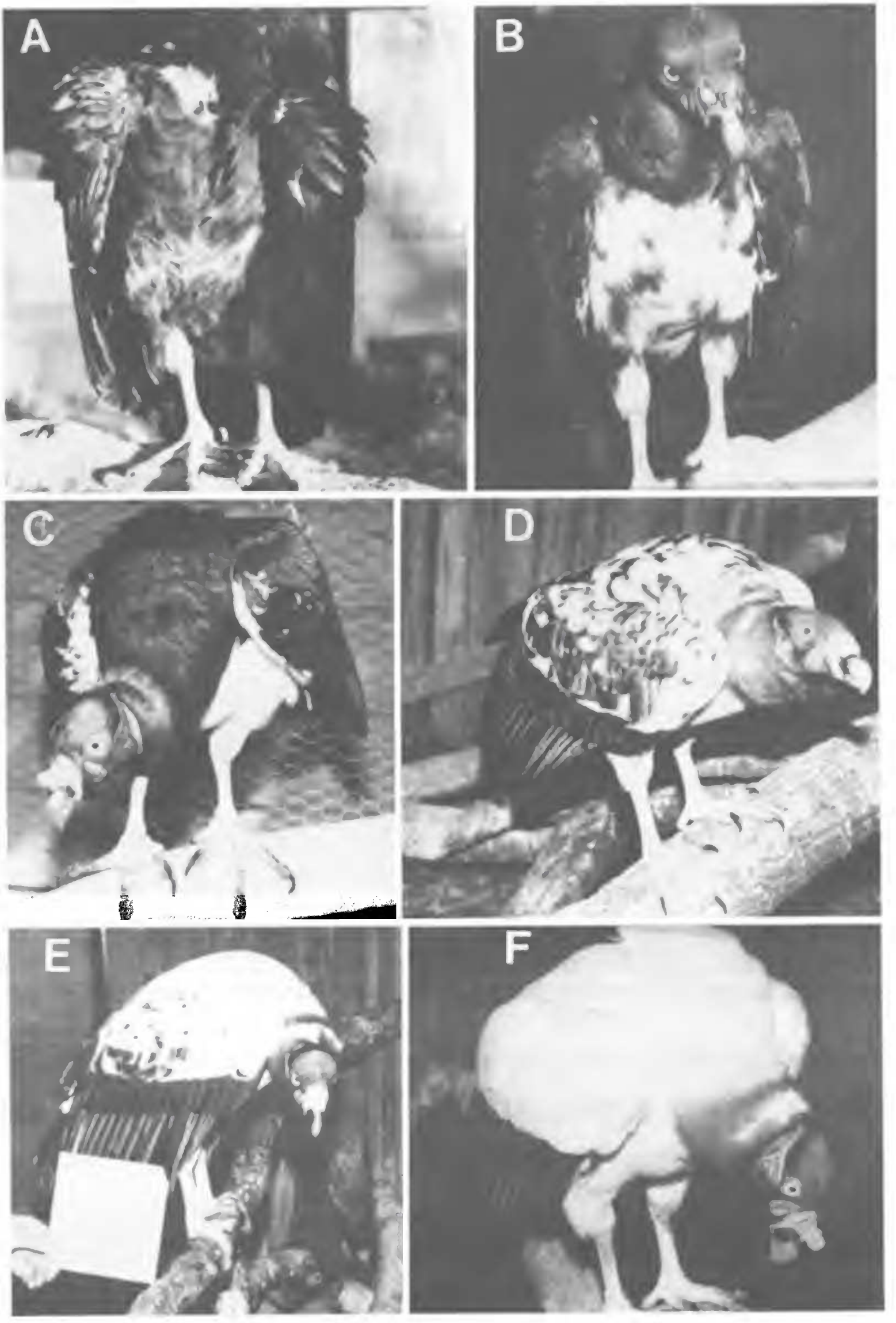
A
B
C
D
E
F

Table 1. Plumage color criteria for estimating age classes in king vultures.

AGE, yr	COLORATION CHARACTERISTICS
1–2	Sooty black coloration with downy feathers observable on femoral and crural tracts
2–3	Ventral tract with varying amounts of white
3–5	Ventral tract feathers white; white feathers of alar tract less than 50% white
5–7	Specks of black remain in lesser wing coverts of alar tract
6–>7	White feathering includes: interscapular and dorsal regions of spinal tract, ventral tract and underwing coverts of caudal tract. Seven middle upper coverts, carpal coverts, and all underwing coverts as well as all feathers of the femoral and crural tracts

ventral, and crural tracts. Although the number of third-year birds observed was limited to four, in all cases at least 50% of the ventral, femoral, and crural tracks became white. During the fourth year, coloration resembled the third year with ventral, femoral, and crural tract feathers white. At this age the alar tract region, e.g., upper wing coverts ($N = 3$), also was <50% white. A mottled appearance, due to the intermixing of white feathers on the interscapular area of the spinal tract and alar tracts, occurred in 75% ($N = 4$) of fifth-year birds. One individual obtained this mottled appearance in its fourth year. Of the three birds in their sixth or seventh year, only one had reached definitive plumage (a sixth-year individual). The other two retained specks of black in the upper wing coverts.

In addition to the small number of specimens examined, several additional considerations should be made in evaluating the aforementioned data and conclusions. First, given that only 50% of the individuals examined were of known sex, no conclusions could be drawn regarding the possible variation due to sex alone. Such an influence has not been determined in other monomorphic species that require long periods for plumage maturation (Jollie 1947, Palmer 1988, Snyder 1988). Hence, it is unlikely that it would prove so with this species. Additionally, while king vultures maintained in Texas were within the photoperiod and temperature likely experienced by wild birds, the 11 maintained in Detroit were not housed under such natural conditions. It should be noted, however, that previous studies on king vulture development were conducted with birds in captivity in north-temperate-zone environments (Heck 1968, Schlee 1994). Secondly, no published account exists on the annual molt cycle in king vultures. Dickey and van Rossem (1938) state that the species goes through an annual molt in August. Contrary to this, five captive birds that I maintained molted throughout the year (Eitniear unpubl. data). Without knowing the molt cycle, correlating feather replacement with age appears tenuous.

Using a captive bird, Todd and Gale (1970) determined that the California condor (*Gymnogyps californianus*) primary molt requires 2 yr, and Koford (1953) indicated that a complete body-feather molt requires more than 1 yr in the California condor. To prevent excessive loss of flight efficiency (Tucker 1991), it is likely that the king vulture requires a similar period of time. In addition, significant variability in predefinitive feathering tends to hamper assigning chronological age or plumage reliably to individual king vultures. Such variability is common in birds requiring a lengthy period for maturation. Wilbur (1975) and Snyder (1968) noted that too much variation in plumage color exists within age cohorts of California condors to permit precise age determination of them. Wilbur did, however, suggest age categories of 1–3 yr (immatures), 3–4 yr (ringnecks), and 4–5 yr (subadults). He further suggested that first-year birds be aged based upon behavior and locality (Wilbur 1975). This situation is similar to that described by Palmer (1988) in bald eagles (*Haliaeetus leucocephalus*) as well as in golden eagles (*Aquila chrysaetos*; Jollie 1947), and northern goshawks (*Accipiter gentilis*; Sushkin 1928). Additional information on king vulture molt might provide some additional characters, e.g., stage of molting and feather shape that could augment coloration in age class determination. Until further information becomes available detailing the molt cycle in king vultures, the utility of using only plumage color characters as reliable aging criteria is limited.

RESUMEN.—Se investigo el posible uso de criterios de cambios en el color del plumaje para estimar la edad de Carroñero Rey (*Sarcoramphus papa*). El análisis de 27 fotographias representando a 16 indivuos a diversas edades, indica que se distinguir cinco categoriás de edad. El primer ano se puede diagnosticar por la presencia de plumón. Las aves de dos años empiezan a mostrar coloración blanca en las áreas ventrales. Este reemplazo de plumas negras por blancas continua hasta que las aves alcanzan cuatro años de edad cuando tienen un aspecto moteado resultado de una matrix de plumas blancas y negras en el dorso. La etapa final de maduración del plumaje ocurre a los seis o siete años de edad cuando las "manchas" de negro en las coberteras superiores del ala son finalmente reemplazadas por plumas blancas. Se expresa cierta reserva en la confiabilidad de los criterios de color ya que existe una gran variabilidad en esta como en otras especies con periodos de madurez prolongados.

[Traducción de Ernesto Enkerlin]

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Figure 1. Age estimations based on plumage color development in king vultures. A. 1–2 yr, B. 2–3 yr, C. 3–4 yr, D. 4–5 yr, E. 6–7 yr, F. 7–8 yr.

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BIGAMY IN RED-TAILED HAWKS IN SOUTHWESTERN YUKON

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KEY WORDS: *bigamy*; Buteo jamaicensis; *hare cycle*; *plumage pattern*; *red-tailed hawk*; *Yukon.*

Polygyny is well documented in some raptor species (Newton 1979), and is usually associated with an abundant food supply as seen in hen harrier (*Circus cyaneus*) populations in Orkney (Balfour 1962), and common buzzard (*Buteo buteo*) populations in Scotland (Picozzi and Weir 1974). In red-tailed hawks (*Buteo jamaicensis*), only two cases of polygyny have been reported (Wiley 1975, Santana et al. 1986). In both cases two females shared the same mate and nest, but no information on food availability was available.

Here I describe three incidents of bigamy in a red-tailed hawk population. In these incidents a male was mated with two females at different nests, during years of declining prey abundance.